5. Studies on Atomic and Molecular Process

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《結果》

亜鉛ニオブ酸鉛とチタン酸鉛の固溶の割合を$(1-x)Pb(Zn_{1/3}Nb_{2/3})O_3-xPbTiO_3$としてxを用いて表わすことにする。本稿においては、室温付近において菱面体晶と正方晶のモルフォトロピック相境界があるものを含んだ ①x=0 ②x=0.07 ③x=0.095 という割合の３種類の試料の温度変化時の観察結果を写真にして示した(fig.4)。

ペロブスカイト型結晶構造を持つ強誘電体の多くは、キュリー温度において、強誘電相と常誘電相との間で相転移をする。亜鉛ニオブ酸鉛のように複合ペロブスカイトでランダムなイオン配列をもつものでは、イオン分布の統計的な不均一さなどのために、キュリー温度が局所において異なり、そのために相転移が広い温度領域にわたって散漫になる。そして、特に低温においては強誘電相の緩和的な誘電分散、すなわち誘電率の周波数依存性が顕著にみられる。亜鉛ニオブ酸鉛にチタン酸鉛を加えるに従い、その相転移はシャープになっていくが、今回の実験では、その分域構造も細かい紡錘形の分域から明瞭で直線的な分域へと変化するということが実際に観察された。つまり、上で述べた強誘電体の相転移の散漫さや誘電緩和性は、分域の動的な挙動と密接な関係があるということがわかった。

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5. Studies on Atomic and Molecular Process

Byong Soo Min

This paper consists of three parts. The first is on the supersonic nozzle beam, the second is on the threshold-electron photo-ion coincidence (TEPICO) technique, third is on the electron-energy-loss spectroscopy.

1. Assessment of the performance of the supersonic nozzle beam.[1)]

In any experiment that uses a molecular beam, it is advantageous to introduce the supersonic nozzle beam because of its strong intensity, narrow velocity distribution, and, stable inner state of the beam. As the first step of the assessment of the beam quality, we measured the velocity distribution in a neon beam by the time-of-flight (TOF) method for the supersonic nozzle beam apparatus at the Institute for Laser Science, University of Electro-Communications. Figure 1 shows a diagram of the experimental setup. Figure 2 shows the measured beam intensity as a function of flight-time. We obtain the velocity distribution and the Mach-number of the beam, which characterizes the beam quality, by the technique of fitting a theoretical distribution curve to the

measured TOF data. Details of the procedure will be discussed at the meeting.

2. Study on the dissociative-ionization process of molecules by means of the coincidence technique.

We performed a study on the dissociative-ionization processes of CO_2 and CH_4 molecules by means of the threshold-electron photo-ion coincidence (TEPICO) technique using the synchrotron radiation facility at the Institute for Molecular Science. The experimental apparatus is shown in figure 3. Monochromatic vacuum ultraviolet (VUV) light is introduced from a 1m Seya-Namioka monochromator equipped with the BL2B2 beam line of the UVSOR facility.[2] In this study, we have adopted the angular discrimination technique using a capillary array plate (CAP) for the threshold electron, and, the method of TOF mass spectroscopy to detect photo-ion. In figure 4, we show the threshold-electron spectrum of CO_2 in the wavelength region between 600 and 660 Å. The highest peak is for the $C^2\Sigma g^+(0,0,0)$ state of CO_2^+ at 639.4 Å. Since the $C^2\Sigma g^+$ is fully dissociative,[3] we measured two kinds of the ion TOF mass spectra at wavelength 639.4 Å. The top of the figure is the simple TOF mass spectrum without coincidence, the bottom is the spectrum measured by the TEPICO method. The largest peak in the top figure is for the CO_2^+ due to the ionization of outer valanced electron. Only two peaks are measured by TEPICO spectrum, and the peak of CO_2^+ becomes notably small compared with that of the simple TOF. These measurements manifest that the $C^2\Sigma g^+(0,0,0)$ state of CO_2^+ is fully dissociative into O^+ and CO. The details will also be discussed at the meeting.

3. Measurements of differential cross section for excitation to the 2^1S and the 2^3S states in helium by means of the electron-energy-loss spectroscopy.

We measured the differential cross sections (DCS) for excitation from the 1^1S ground state to the 2^1S and 2^3S states in helium as functions of scattering angle for the collision energy region from 200eV to 1KeV. We are specially interested in the behavior of the DCS at small scattering angles including zero degree. A part of the results have been already presented at an international conference.[4]

Conclusion

(1)Mach-number in the beam is determined from the measured TOF distribution by the fitting calculation.

(2) The $C^2\Sigma g^+(0,0,0)$ state of CO_2^+ is fully dissociative into O^+ and CO.

(3) The DCS for excitation to the 2^3S state in helium increases remarkably at zero scattering angle for high collision energies.

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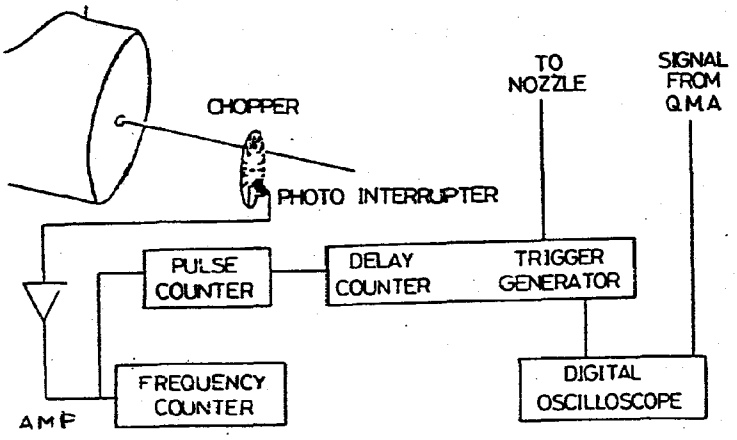

Fig. 1 Experimental setup of TOF measurement

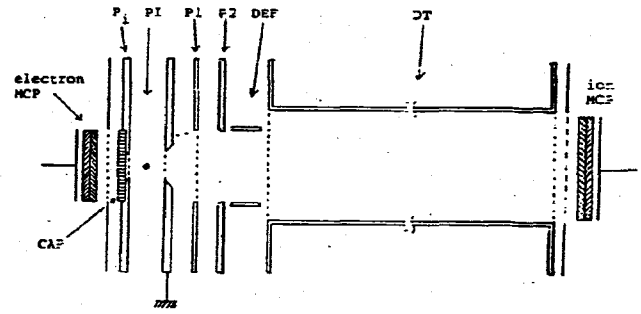

Fig. 3 Schematic view of TEPICO spectrometer

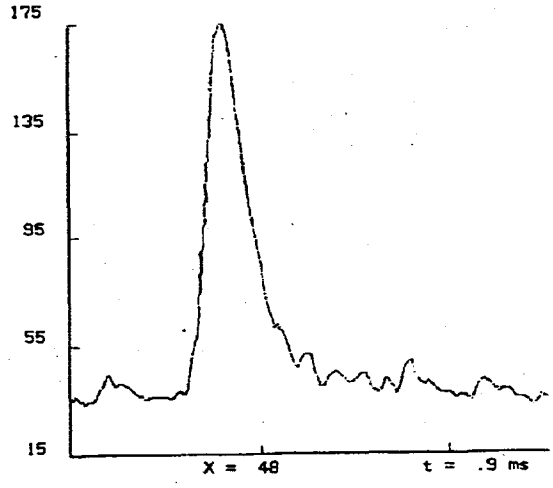

Fig. 2 Beam intensity of Ne as a function of flight-time

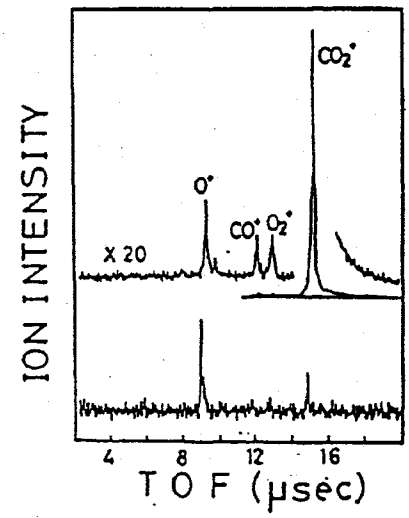

Fig. 4 TOF spectra of CO_2 at 639.4 A
Top : without coincidence
Bottom : with coincidence

6. 走査型トンネル顕微鏡の試作

長尾淳史

《序論》 走査型トンネル顕微鏡(Scanning Tunneling Microscope: ＳＴＭ)は、原子的スケールの分解能を有する顕微鏡である。電子顕微鏡などと比べると、特に垂直方向の分解能に優れており(図１)、原子の大きさの約１００分の１のオーダーが実現されている。また、ＳＴＭは真空中のみならず大気中においても動作が可能なことから、１９８１年に発明されて以来８年足らずで、物理学の分野のみならず、ＤＮＡやウイルスの測定などの生物学への応用もさかんに行われている。

一般に、ＳＴＭの駆動素子にはＰＺＴ系圧電セラミクスが多く用いられている。しかし、ＰＺＴ系圧電セラミクスには変位特性に大きなヒステリシスが存在し、ＳＴＭ像の歪みの大きな原因となっている(図２)。そこで我々はＰＬＺＴ系セラミクスを用いてヒステリシスの少ない駆動素子用材料の開発を行うと同時にＳＴＭシステム全体の試作を行った。